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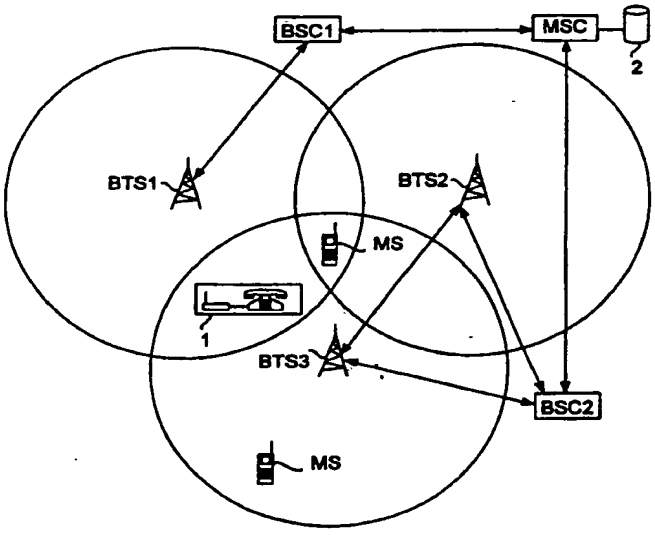

(57) Abstract

The present invention relates to a method of allocating a home cell to a subscriber station of a cellular radio system. For choosing the best possible cell as the home cell for the subscriber station, the subscriber station is freely allowed to use any radio cell or a certain limited group of several optional radio cells within the system. When the subscriber station establishes a connection through a given radio cell, an identifier indicating the radio cell being utilized is stored in a register. The radio cells, the subscriber station has utilized the most, are identified on the basis of the data stored in the register, and at least one of said radio cells, the subscriber station has utilized the most, is allocated as the home cell to the subscriber station.

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METHOD OF ALLOCATING A HOME CELL TO A SUBSCRIBER STATION

The present invention relates to a method of allocating a home cell to a subscriber station of a cellular radio system. The invention further relates to a cellular radio system comprising a mobile services switching centre, base stations comprising means for providing telecommunication connections by radio frequency signals to the subscriber stations located in their coverage area, means for controlling the base stations to forward telecommunication signals between the subscriber stations and the mobile services switching centre, and a subscriber station which can use one of the several optional base stations for establishing telecommunication connections.

The invention relates primarily to a WLL system (Wireless Local Loop), i.e. a system utilizing fixed subscriber stations whose telecommunication signals are transferred on the radio path by utilizing a cellular radio system, although the invention can also be applied in other connections. Since the subscriber stations in WLL systems are normally fixedly installed at a specific location, it is usually not necessary to provide mobility for said subscriber stations, i.e. the capability of establishing a telecommunication connection via any base station of the system. Even if the WLL subscriber stations were subscriber stations in a cellular radio system also comprising mobile subscriber stations to which the system provides the aforementioned mobility, it is advantageous if the mobility could be eliminated, or at least restricted to specific cells from the WLL subscriber stations which do not necessarily require free mobility. By doing this, the number of necessary location updates and handover operations can be minimized, thus saving on system resources. Consequently, in connection with the WLL systems, there is a need to allocate a home cell to each subscriber station.

In known solutions a home cell has been allocated to a given subscriber station in such a way that when the subscriber station is added to the system, an operator has, e.g. by using a map, checked which radio cell is likely to cover best the geographical area in which the subscriber station will be placed. Next, the operator has allocated said radio cell as the home cell to the subscriber station. The most significant disadvantage of this known solution is that the field strength of a radio cell may vary considerably within the cell from one location to another especially in urban areas where buildings interfere with signal propagation. Thus, choosing a home cell for the given subscriber station may fail if the home cell is chosen exclusively on the basis of a

map. For practical reasons it is impossible for the operator to send maintenance personnel to perform field strength measurements at the location of each subscriber station because of the great amount of work involved.

It is an object of the present invention to solve the aforementioned problem and provide a method for allocating a home cell to a subscriber station by choosing the most suitable home cell for each subscriber station in a reliable and easy manner. This object is achieved by the method of the invention, characterized by allowing the subscriber station freely to employ any radio cell, or a certain limited group of several optional radio cells within the scope of the system for establishing telecommunication connections, storing at least an identifier of a radio cell being utilized in a predetermined register when the subscriber station establishes a connection through the radio cell, or when a connection is established to the subscriber station through the radio cell, identifying the radio cells most used by the subscriber station according to the data stored in said register, and allocating at least one of said most used radio cells as the home cell to the subscriber station.

The invention is based on the idea that when a home cell is being allocated to a given subscriber station, the subscriber station is first allowed to freely use any radio cell or a certain limited group of several optional radio cells within the scope of the system for establishing telecommunication connections. In other words, said subscriber station is first allowed either totally free mobility or at least free mobility in certain predetermined cells. The subscriber station can then establish a connection through the selected radio cell of the system, naturally provided that there is a free channel available in said cell. If the subscriber station in question is mobile in a restricted area or alternatively an immobile one, such as a WLL subscriber station, it is possible that said subscriber station is located immobile at a point where several optional radio cells are audible. Consequently, the subscriber station attempts to choose the radio cell with the best audibility. It is also possible that the audibility of a radio cell is temporarily better or poorer at different times, and therefore the subscriber station does not necessarily always choose the same radio cell when establishing a telecommunication connection. In accordance with the invention, statistics are kept on the radio cells being used by the subscriber station and, after a period of time, the most utilized cell, i.e. the best home cell for the subscriber station, can be determined on the basis of the statistics. In accordance with the invention, data can be assembled to said statistics e.g. on

the length of calls made from the subscriber station through different cells, and on the number of calls made by the subscriber station through different cells. Furthermore, data can be assembled to the statistics on the traffic load (e.g. quiet/peak hour) of the cell being used, on the traffic load of the neighbouring cells of the cell in use, and on field strength measurements of the cell in use and of the neighbouring cells.

The most significant advantages of the method of the invention are that when allocating a home cell, the actual audibility of different cells at the installation site of the subscriber station can be taken into account without a need for field strength measurements at the installation site, that a new home cell can be allocated to each subscriber station with little effort after a change has taken place in the network, and that the method of the invention can be utilized also in existing systems because the required changes to the existing cellular radio systems can be made e.g. by changing the software of the mobile services switching centre.

The method of the invention can also be utilized continuously, i.e. the system can e.g. continuously monitor the cell through which the subscriber station has attempted to establish a connection, in which case the home cell or home cells of the subscriber station can be reallocated automatically, e.g. at fixed intervals.

The method of the invention can also be applied in the allocation of more than one home cell to a given subscriber station. If a subscriber uses the same subscriber station, e.g. both at his summer house and at his town residence, two home cells located at a distance from each other can, in this case, be allocated to the subscriber station. In accordance with the invention, groups of home cells can also be allocated to the subscriber station, each group comprising several adjacent cells. Thus, the subscriber station can be provided with the most suitable radio cell from the group of home cells.

The invention also relates to a cellular radio system, wherein the method of the invention can be applied. The system of the invention is characterized in that the system comprises register means for storing data needed for the identification of the base stations through which said subscriber station establishes a telecommunication connection, or through which a connection is established to said subscriber station, and means for identifying the base stations which said subscriber station utilizes most in its telecommunication connections.

The preferred embodiments of the method and system of the invention are disclosed in the attached dependent claims 2 to 4 and 6 to 9.

In the following, the invention will be described in more detail by means of a few embodiments with reference to the accompanying drawings, in which

Figure 1 shows a flow diagram of a first preferred embodiment of the method of the invention.

Figure 2 shows a block diagram of a first preferred embodiment of the system of the invention.

Figure 3 shows a block diagram of a second preferred embodiment of the system of the invention, and

Figure 4 shows a block diagram of a third preferred embodiment of the system of the invention.

Figure 1 shows a flow diagram of a first preferred embodiment of the method of the invention. In block A in Figure 1, free mobility in the system is first offered to a given subscriber station to which a home cell is to be allocated, i.e. the subscriber station can freely employ any base station within the system for establishing a telecommunication connection. Alternatively, the subscriber station can be allowed free mobility in a specific group of cells. The subscriber station in question can be a new subscriber station which is recently put into use, or alternatively, the subscriber station may have a previously allocated home cell, and the operator wishes to check, e.g. because of an alteration in the network, if the home cell of said subscriber station should be changed.

In block B, the system monitors the subscriber station for detecting mobile terminating calls or, correspondingly, mobile originating calls.

When a mobile terminating call or a mobile originating call is detected, the identifier needed for the identification of the cell/base station is in block C stored in a predetermined register. At the same time, either during or after the call, it is also possible to store the connection time in the register, i.e. the duration of the connection from the subscriber station through said cell/base station, data on the traffic load in said cell/base station (i.e. the amount of capacity of the cell/base station in use at the moment), and data describing the traffic load in the neighbouring base stations of said cell/base station. Furthermore, it is possible to store data in the register regarding how well the subscriber station can receive signals of different radio cells. A sub-

scriber station of e.g. the GSM mobile telephone system reports to the system measurement data regarding the base station it uses and the six strongest neighbouring stations whose signals it can receive. In accordance with the invention, this measurement data, too, can be stored in said register.

The subscriber station can be monitored e.g. for a predetermined time before allocating the actual home cell of the subscriber station. Alternatively, the home cell can be allocated after a predetermined number of events regarding the subscriber station have been registered in said register. In that case, routine proceeds through block D to block E. Allocating a home cell can also be an ongoing process, i.e. the subscriber station is continuously monitored, after which the home cell of the subscriber station can be automatically reallocated, e.g. at certain predetermined intervals.

In block E, the identifiers of the cells which said subscriber station has utilized the most for establishing telecommunication connections are determined with the help of the data recorded in the register.

In block F, one of the cells the subscriber station uses the most is allocated as the home cell to the subscriber station. The selection can be based either on the number of times the cell has been used by the subscriber station or on total connection times. Thus, the cell the subscriber station has used the most is not necessarily chosen automatically as the home cell, but other factors can also be considered in the selection. For example, if the cell which the subscriber station uses the most includes on average significantly more traffic than the cell which is the next most used, the latter can be allocated as the home cell (naturally providing that they are overlapping neighbouring cells covering nearly the same area). In the allocation of a home cell, the data on the traffic load and test measurements described in connection with block C can be utilized, enabling the selection of e.g. the cell wherein the traffic load has not normally been significantly greater than in the neighbouring cells when used by the subscriber station. According to the invention, instead of one home cell, several home cells or groups of home cells can be allocated to the subscriber station on the basis of the data obtained when monitoring the subscriber station.

Figure 2 illustrates a block diagram of a first preferred embodiment of the cellular radio system of the invention. The cellular radio system in Figure 2 can e.g. be a part of the GSM system (Groupe Spécial Mobile).The system in Figure 2 is utilized for providing telecommunication connections both to mo-

bile stations MS and to WLL subscriber stations 1, which are meant to be installed fixedly at specific locations.

The system in Figure 2 comprises a mobile services switching centre MSC which provides services to the subscriber stations MS and 1 in the coverage area of the system through two base station controllers BSC1 and BSC2 and three base transceiver stations BTS2 and BTS3.

The WLL subscriber station 1 in Figure 2, consisting of a terminal comprising a radio part and a tele adapter, and a user interface, i.e. a fixed network telephone connected to the terminal, is located at a point where it can utilize either of the base stations BTS2 and BTS3 for its telecommunication connections. If the system operator wishes to allocate a home cell to the subscriber station 1, then, according to the invention, the subscriber station is first offered free mobility in the system or, alternatively, free mobility in certain parts of the system for a given time, e.g. during a learning phase. Thus, the subscriber station (assumed to be installed fixedly at the location presented in Figure 2) can freely use either of the base stations BTS1 and BTS3. The mobile services switching centre MSC monitors the subscriber station 1 during said learning phase and in connection with each telecommunication connection records a note in a register 2 regarding the cell/base station through which the subscriber station 1 has established a connection. The register can be in connection with e.g. the HLR (Home Location Register) of the mobile services switching centre.

When said learning phase is completed, the base station which the subscriber station has used the most is identified on the basis of the data stored in the register 2. The cell maintained by the most used base station should, of course, primarily be allocated as the home cell to said subscriber station unless there are other reasons for choosing some other cell. When the home cell has been allocated to the WLL subscriber station, the mobile services switching centre stores the data concerning the home cell in the register 2. After this, the mobile services switching centre can prevent said subscriber station from utilizing other cells, and, consequently, the number of location updates and handovers needed in the system can be reduced. Even if the subscriber station 1 should request a traffic channel from a cell other than its home cell, the mobile services switching centre MSC together with the base station controller BSC1 will provide said subscriber station with traffic channels only from the home cell of the subscriber station. In addition, a situation where

a subscriber station located stationary in the border zone of two neighbouring cells would continuously perform handover operations can be prevented by the solution of the invention.

In the system in Figure 2, a home cell, or several home cells can naturally be allocated to the mobile station MS in the corresponding manner as described above, whereby an operator can e.g. offer price reductions to said mobile station when the mobile station uses one of its home cells for establishing a connection.

Figure 3 illustrates a second preferred embodiment of the system of the invention. The embodiment in Figure 3 corresponds to the case in Figure 2 in other respects except that in the embodiment in Figure 3, a register 3 for maintaining data on the base stations used by the subscriber station MS during the learning phase (when the base station is being allocated) is arranged in connection with the base station controller BSC3 and not in connection with the mobile services switching centre, as is the case in Figure 2. Thus, during the learning phase, data are recorded in the register 3 only when the subscriber station MS has utilized the cells BTS4 or BTS5. Correspondingly, when the learning phase is completed and a home cell, or home cells have been allocated to the subscriber station, the data concerning the home cells are stored in the register 3 of the base station controller, from where the data can be retrieved when a connection is established to the subscriber station MS.

The embodiment in Figure 3 also enables the system to take into account the data concerning the home cell of the subscriber station MS only as long as the subscriber station is located in the coverage area of the base stations BTS4 to BTS5 controlled by the base station controller BSC3. Thus, if the subscriber station is temporarily located e.g. in the cell of a base station BTS6, or in some other cell not dependent on the base station controller BSC3, the system ignores the data stored in the register 3 of the base station controller BSC3.

Figure 4 shows a block diagram of a third preferred embodiment of the system of the invention.

Figure 4 illustrates a situation where two groups of home cells have been allocated to the subscriber station MS. The first group of home cells comprises three adjacent neighbouring cells A, and, correspondingly, the second group of home cells is composed of four adjacent cells B. Figure 4 shows

that the first group of home cells and the second group of home cells are located at a distance from each other.

In the system in Figure 4, the operator has been able to specify that the mobile station MS is allowed to set up calls only from the home cells A and B allocated to it, but, during the connection, e.g. when required by the traffic load, the system can, however, also transfer said subscriber station by a handover operation to a cell which has not been allocated as a home cell to the subscriber station MS.

It is to be understood that the above description and the related figures are only intended to illustrate the present invention. It will be apparent to those skilled in the art that many variations and modifications can be made to the invention without departing from the scope and spirit of the invention disclosed in the attached claims.

CLAIMS:

1. A method of allocating a home cell to a subscriber station of a cellular radio system, **characterized** by

allowing the subscriber station freely to employ any radio cell, or a certain limited group of several optional radio cells within the scope of the system for establishing telecommunication connections,

storing at least an identifier of a radio cell being utilized in a predetermined register when the subscriber station establishes a connection through the radio cell, or when a connection is established to the subscriber station through the radio cell,

identifying the radio cells most used by the subscriber station according to the data stored in said register, and

allocating at least one of said most used radio cells as the home cell to the subscriber station.

2. A method as claimed in claim 1, **characterized** in that several home cells are allocated to the subscriber station.

3. A method as claimed in claim 1, **characterized** in that home cell groups located at a distance from each other are allocated to the subscriber station, each group of home cells consisting of a group of adjacent cells.

4. A method as claimed in any one of claims 1 to 3, **characterized** in that when the home cell or home cells have been allocated to the subscriber station, the subscriber station is prevented from utilizing other cells than its home cells in telecommunication connections by allocating only traffic channels of the home cells to be used by the subscriber station.

5. A cellular radio system comprising

a mobile services switching centre (MSC),

base stations (BTS1 to BTS6) comprising means for providing telecommunication connections by radio frequency signals to subscriber stations (MS, 1) located in their coverage area,

means (BSC1 to BSC4) for controlling the base stations to forward telecommunication signals between the subscriber stations and the mobile services switching centre, and

a subscriber station (1, MS) which can use one of the several optional base stations for establishing telecommunication connections,

characterized in that the system comprises

register means (2,3) for storing information needed for the identification of the base stations (BTS2, BTS3, BTS4, BTS5) through which said subscriber station (1, MS) establishes a telecommunication connection, or through which a connection is established to said subscriber station, and

means (MSC, BSC3) for identifying the base stations which said subscriber station has utilized the most in its telecommunication connections.

6. A system as claimed in claim 5, **characterized** in that the system comprises controller means (MSC, BSC3) for allocating at least one home base station to the subscriber station from the base stations (BTS2, BTS3, BTS4, BTS5) which the subscriber station has utilized the most on the basis of the register means (2,3), the controller means (MSC, BSC3) being arranged to prevent the establishment of a telecommunication connection between the subscriber station (1, MS) and some other than a home base station.

7. A system as claimed in claim 5, **characterized** in that the system comprises control means for allocating several home base stations to the subscriber station from the base stations (BTS2, BTS3, BTS4, BTS5) the the subscriber station has utilized the most on the basis of the register means.

8. A system as claimed in claims 6 or 7, **characterized** in that the control means (MSC, BSC3) are arranged to prevent the establishment of a telecommunication connection between the subscriber station and some other than a home base station by allocating a traffic channel to the subscriber station (1, MS) from a home base station in response to a call from the subscriber station irrespective of the base station through which the call is transmitted from the subscriber station.

9. A system as claimed in any of claims 5 to 8, **characterized** in that said cellular radio system is the GSM-system.

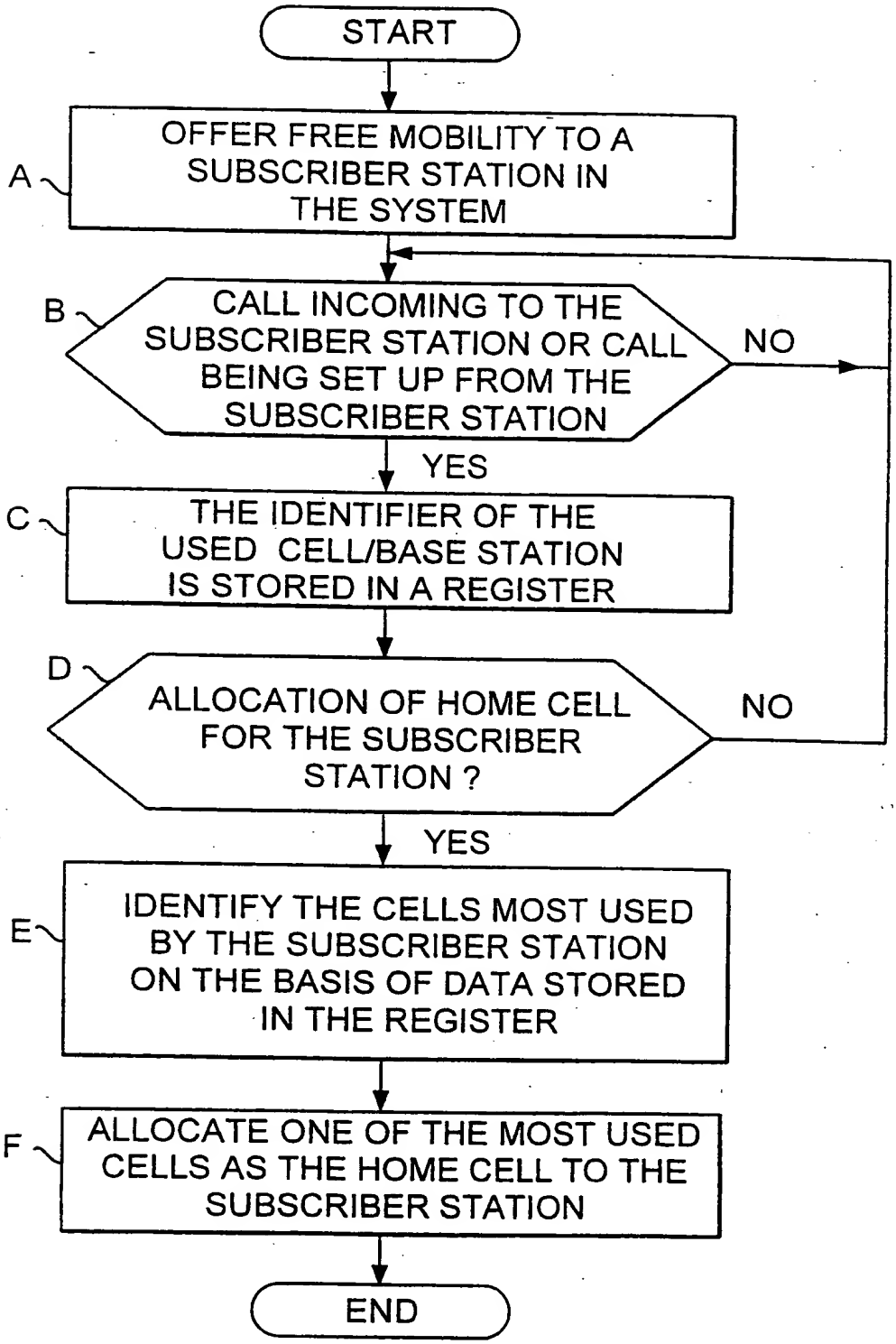
START
A
OFFER FREE MOBILITY TO A SUBSCRIBER STATION IN THE SYSTEM
B
CALL INCOMING TO THE SUBSCRIBER STATION OR CALL BEING SET UP FROM THE SUBSCRIBER STATION
NO
YES
C
THE IDENTIFIER OF THE USED CELL/BASE STATION IS STORED IN A REGISTER
D
ALLOCATION OF HOME CELL FOR THE SUBSCRIBER STATION ?
NO
YES
E
IDENTIFY THE CELLS MOST USED BY THE SUBSCRIBER STATION ON THE BASIS OF DATA STORED IN THE REGISTER
F
ALLOCATE ONE OF THE MOST USED CELLS AS THE HOME CELL TO THE SUBSCRIBER STATION
END

FIG. 1

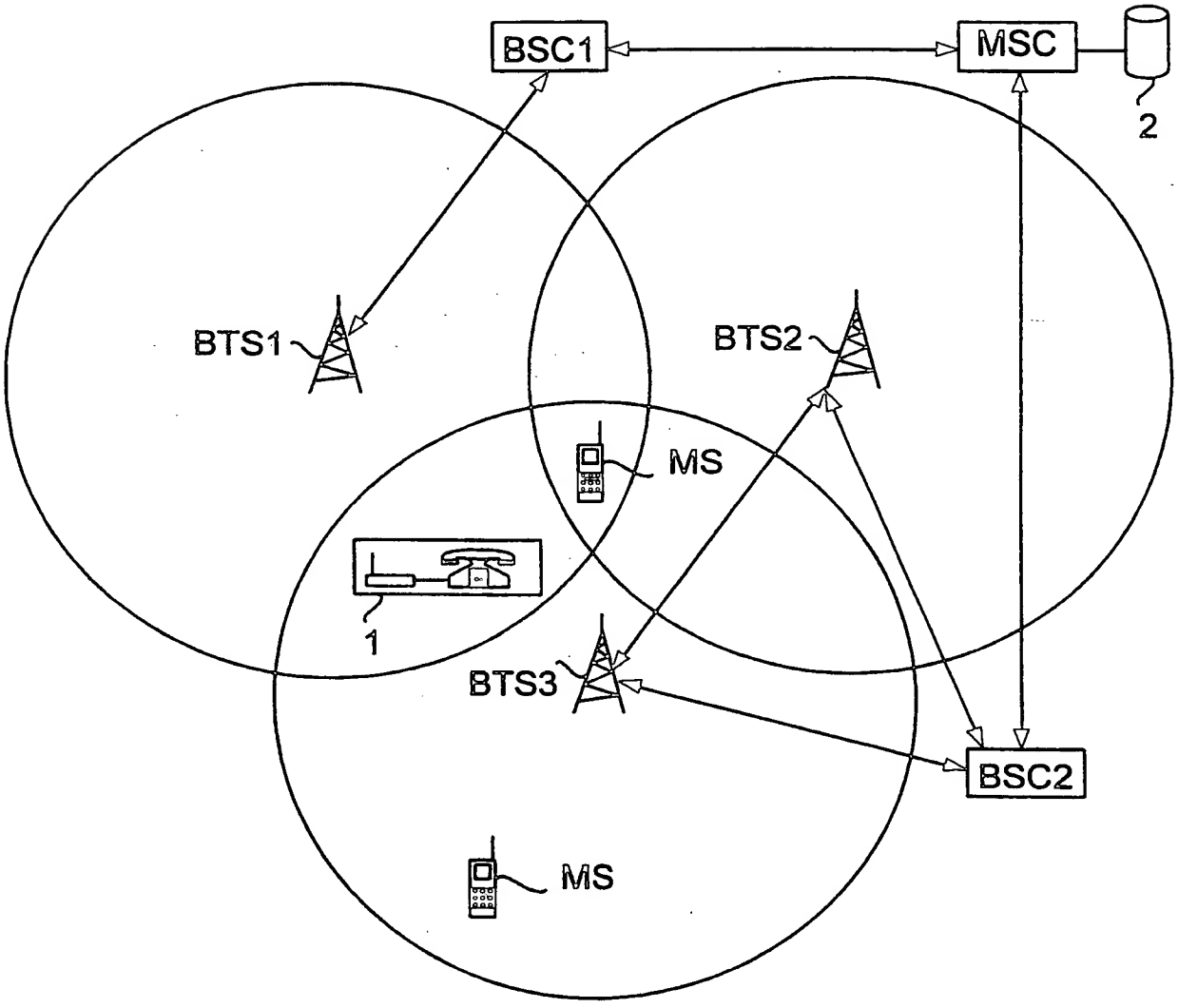

FIG. 2

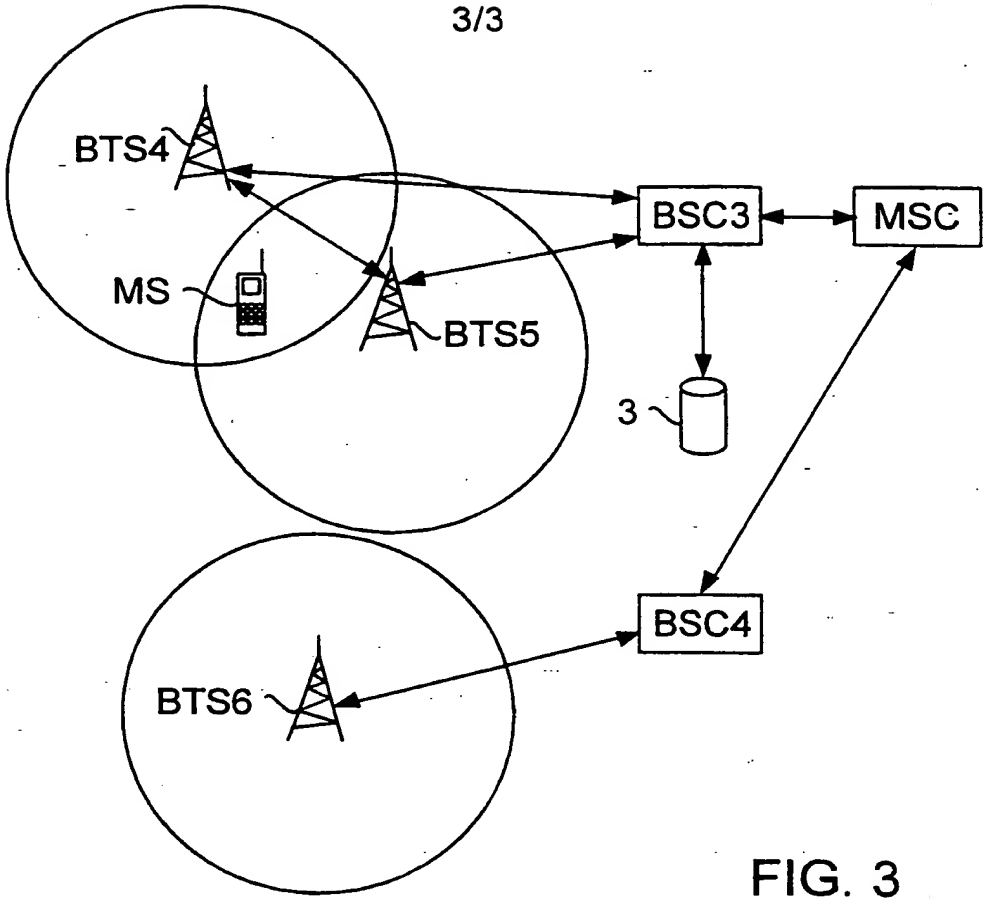

FIG. 3

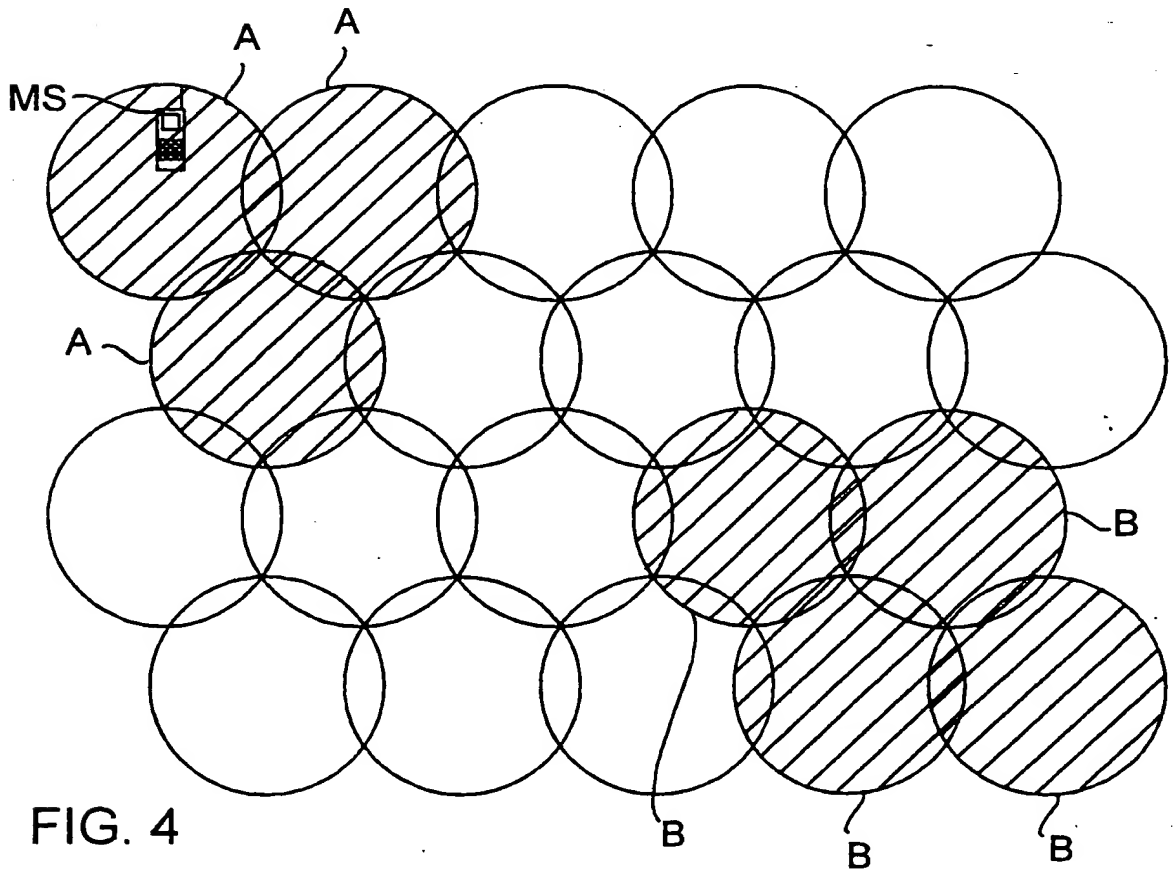

FIG. 4